A Low Cost Strategy for Reducing Agricultural Nonpoint Pollution in Lake Erie[1]

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INTRODUCTION

The Lake Erie Wastewater Management Study is to develop a recommended management program for agricultural sources of pollution. The procedure is to identify land management practices which reduce pollutant loadings in the Lake Erie Basin, to quantify the effect of these practices on pollutant loadings, and to determine the economic cost of implementing management practices which reduce pollutant loadings.

A host of management practices to reduce pollutant loadings are available including terracing, contouring, crop rotations, winter cover crops, diversion, grass waterways, outlet protection, stream bank protection, windbreaks, sediment basins, and reduced tillage technologies. While all of these management practices may have an impact of improving water quality, reduced tillage technologies seem to be the most effective practices to improve water quality. These technologies allow intensive row crop production while maintaining winter cover of the soil during erosion sensitive winter and spring months. Results of an earlier study in a small watershed in the basin indicate that initial reductions in soil loss are inexpensive if reduced tillage technologies are adopted on selected soils (Forster and Becker).

The general purpose of this study is to determine the economic effects of using minimum and no tillage technologies in the Lake Erie Basin.[2] Specific objectives are:

(1) to estimate gross returns and costs of production for major crops on each soil series in the Basin,

(2) to determine the effect of reduced tillage technologies on gross returns and cost of production for corn and soybeans.

(3) to develop a simulation model which represents the economic impacts of alternative crop management practices in the Lake Erie Basin, and

(4) to estimate the economic impacts for the Basin of adopting minimum tillage and no tillage technologies on selected soils.

DATA USED IN THE ANALYSIS

Soil Series Data

Soils vary widely over the Lake Erie Basin. Some glaciated soils are highly productive with high organic matter and level to gently sloping topography. These soils cover much of the western part of the Basin and are important sources of corn, soybeans, tomatoes, sugar beets and other row crops. At the other extreme are soils formed over sandstone and shale parent material, having low organic matter content, and are relatively unproductive with gently to steeply sloping topography. These soils are found in the eastern portion of the Basin.

The Buffalo District of the Corps of Engineers and Resource Management Associates (RMA) provided soil series data for the Basin. Briefly, for each county in the Basin, soil series were identified and the number of hectares of each soil series was listed. Over 370 soil series were identified which accounted for nearly all of the 3.7 million hectare cropland area in the Basin.

Yield Data

Average yields were estimated for corn, soybeans, wheat, oats, hay, and other principal crops on each soil series in the Basin. The sources of this data were primarily county soil maps from Ohio, Michigan, Pennsylvania, and New York counties.[3] In addition, a preliminary draft of "Soil Productivity Guide" from the Department of Agronomy at The Ohio State University was reviewed. This publication contained yield estimates for major Ohio soils. Unpublished data on yields by soil series in New York state was used (Reid). This data was thought to be the best available since most of the New York county soil map yield data is obsolete. Finally, published data on yields by soils series for Michigan counties was obtained (Robertson). In short, an attempt was made to obtain the best yield data available since the economic impacts of alternative tillage systems depend largely on these yield estimates.

Soil Management Groups

Each of the 370 soil series was placed in one of five soil management groups. These soil management groups were those identified by Triplett, *et al.* for Ohio soils. Information supplied by the Department of Agronomy at Michigan State University, Robertson, Shaw, and Urban was used to classify soils not found in Triplett, *et al.*

The following brief description of each of the five soil management groups is provided by Triplett, *et al.*:

> Tillage Group 1 - Soils included in this group should have yield response to no tillage equal to or greater than conventional tillage. Soils are moderately well, well, and excessively well drained. They have silt loam, loam, sandy loam, or loamy fine sand surface texture. They are low in organic matter.
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> Tillage Group 2 - These soils should have yield responses to no tillage nearly equal to conventional tillage if soil drainage has been improved. These soils are somewhat poorly drained in their natural state. They have a silt loam, loam, sandy loam, or loamy fine sand surface tecture. They are low in organic matter.
>
> Tillage Group 3 - These soils yield less with no tillage than conventional tillage. They are somewhat poorly to very poorly drained. Tile does not provide adequate drainage. Surface texture is loam, silt loam, or silty clay loam. Most of these soils are low in organic matter.
>
> Tillage Group 4 - Soils in this group may yield less with no tillage than conventional tillage. They are very poorly drained. They have surface textures of silty clay loam, clay loam, silty clay, or clay. They contain relatively high amounts of organic matter in the surface.
>
> Tillage Group 5 - These are organic soils, alluvial soils, and certain fine textured soils. These soils do not respond well to no tillage corn.

Yield Indices

Yield indices were developed for reduced tillage systems for corn and soybeans. Each of the five soil management groups was assigned yield indices for corn and soybeans as shown in Table 1. These indices were based on the best available information. Ohio data was the most complete in assessing yields with reduced tillage. A number of experimental trials conducted by the Ohio Agricultural Research and Development Center in soil management groups 1, 2 and 4 were the basis for the Ohio indices. Soils found in Indiana were assigned the same indices as Ohio soils.

Table 1. Corn and Soybean Yield Indices Under Alternative Tillage Systems by Soil Management Group and State[a]

Soil Management Group	Corn		Soybeans		Corn Soybeans Conventional Tillage
	Minimum	No Till	Minimum	No Till	
			Ohio and Indiana		
1	100	102	100	100	100
2	105	104	103	103	100
3	90	85	90	85	100
4	96	87	95	91	100
5	NA	NA	NA	NA	100
			Michigan		
1	100	100	100	100	100
2	100	100	100	100	100
3	90	85	90	85	100
4	96	87	95	91	100
5	NA	NA	NA	NA	100
			New York and Pennsylvania		
1	100	100	NA	NA	100
2	90	90	NA	NA	100
3	NA	NA	NA	NA	100
4	NA	NA	NA	NA	100
5	NA	NA	NA	NA	100

Sources: Bone, *et al.*; Mokma, *et al.*; Robertson; Triplett, *et al.*; Urban; Reid.

[a]Corn and soybean yields for a particular soil series and tillage method are equal to the yield index times the estimated yield for the series.

Michigan data were adaptations of Ohio data. In Michigan, no published data could be found to support the contention that yield indices were above 100 for reduced tillage systems on soil management groups 1 and 2. Hence, the reduced tillage yields on Michigan soils in management groups 1 and 2 were assumed to be the same as conventional tillage yields.

New York yield indices were based on little experimental evidence. Reid felt that well drained soils would result in the same yields for reduced tillage and conventional tillage systems. However, somewhat poorly drained soils would yield less than conventional tillage, and reduced tillage on poorly to very poorly drained soils would not be feasible. On soil management groups 3, 4, and 5 in New York and Pennsylvania, yields on minimum tillage and no tillage were assumed to be zero. This assumption was expected to significantly affect results since minimum and no tillage systems were used on soil management groups 3 and 4 in part of the analysis.

Commodity Prices

After establishing each soil series' yields for corn (under three tillage systems), soybeans (under three tillage systems), wheat, oats, hay, tomatoes, and sugar beets, product prices and costs of production were estimated. For each commodity, a standard product price was estimated for the 1978-81 period. The basis for these estimates was price projections by Davidson and Ericksen.

If implementation of soil loss control occurs on a national basis, price impacts need to be considered as done by Taylor and Frohberg. That is, as soil loss affects the quantity of crops produced, crop prices would change. For this analysis, incorporating price impacts was thought to be needlessly complex since the proportion of the nation's crop production represented by the Lake Erie Basin is small.

Costs of Production

Production costs were estimated by crop, by tillage system and by county. Briefly, the procedure for establishing the costs were:

(1) Data from Lines, *et al.* were used as a basis for cost of production estimates for Ohio and Indiana crops. Data from Nott, *et al.* were used as a basis for Michigan crops, and New York and Pennsylvania costs were based on Knoblaugh, *et al.*

(2) Equipment costs and labor requirements for minimum and no tillage technologies were adjusted to reflect cost estimates from Rask and Forster. These estimates resulted in minimum tillage equipment costs being about 8 percent less than conventional tillage equipment costs. No tillage equipment costs were about 10 percent less than those for conventional tillage. Similarly, labor requirements (hours/acre) were about 8 percent less with minimum tillage and 10 percent less with no tillage than requirements of conventional tillage.

(3) Fertilizer inputs depended on yield levels and soil characteristics found in each county. For Ohio and Indiana soils, the 1978-79 Agronomy Guide was used to estimate the following relationship for each crop.

$$\text{Nitrogen (lbs/acre)} = a_o + a_1 \text{ (yield)}$$

$$P_20_5 \text{ (lbs/acre)} = b_o + b_1 \text{ (yield)} + b_2 \text{ (phosphorus test)}$$

$$K_20 \text{ (lbs/acre)} = c_o + c_1 \text{ (yield)} + c_2 \text{ (cation exchange capacity)}$$

$$+ c_3 \text{ (potassium test)}$$

County data for cation exchange capacity, phosphorus test, and potassium test were county soil test results from the Ohio Cooperative Extension Service (Follett and Trierweiler).[4] Thus, each soil series in each county had a uniquely determined fertilization rate.

Michigan costs of production were developed in a similar method as the Ohio field crop costs. Information from Warnke, *et al.* was used to develop equations such as:

$$\text{Nitrogen} = a_o + a_1 \text{ (yield)}$$

$$P_20_5 = b_o + b_1 \text{ (phosphorus test)} + b_2 \text{ (yield)}$$

$$K_20 = c_o + c_1 \text{ (yield)} + b_3 \text{ (potassium test)}$$

Less precision was used to estimate Pennsylvania and New York fertilization rates than was done for Ohio, Indiana, and Michigan. Nutrient application rates were only a function of yield.

(4) Land costs were excluded from costs of production. Although these costs are an important cost of production, they remain the same for all crop

management practices. Thus, their exclusion does not affect the relative profitability of tillage systems or cropping patterns.

MODEL DESCRIPTION

The computerized simulation model developed for this study enables the economic impacts of alternative crop management practices to be traced. While the model was designed to compare the impacts of other crop management practices, it also could be used to trace the impacts of other crop management practices such as crop rotations, winter cover crops, contouring, and so forth.

Several data bases mentioned previously were used to develop the return and cost data. The gross return data contained return estimates for each crop and tillage technology in each county and on each soil series. Similarly the cost estimates were unique for each crop and tillage technology in each county and on each soil series.

County crop acreage data was used to develop the proportions of each county's cropland in corn, soybeans, oats, hay, wheat, tomatoes, and sugar beets. Every crop acre in the county was assumed to grow these proportions of crops. This assumption overlooked some important differences between soil series. For example, sloping, unproductive soils were assigned the same crops as level, productive soils in each county. While hardly accurate, this assumption was necessary since data was not available to estimate the crops actually grown on each county's soil series.

Output from the model includes (a) net return per acre by crop, by tillage system, by county, and by soil series; (b) acres in each county by soil management group; (c) net return for each county by "management scenario"; and (d) net return for the Lake Erie Basin by "management scenario".

The "management scenarios" depict returns under the adoption of minimum tillage or no tillage on selected soil management groups. The following chart illustrates the scenarios.

Management Scenario	Soil Management Groups Using Conventional Tillage	Minimum Tillage	No Tillage
A	1,2,3,4, and 5		
B	2,3,4, and 5	1	
C	1,3,4, and 5	2	
D	1,2,4, and 5	3	
E	1,2,3, and 5	4	
F	2,3,4, and 5		1
G	1,3,4, and 5		2

In scenario A, conventional tillage is used on all soils. In B, minimum tillage is used just on soils in soil management group 1, and all other soils are conventional tilled. In C, minimum tillage is used exclusively on soils in soil management group 2 and so forth.

Net Income by Scenario

Net income (excluding land costs) in the Basin totals $338.2 million under conventional tillage. The distribution of this income is noteworthy. While the western counties enjoy large net incomes, eastern counties have relatively small net incomes and, in some cases, negative net incomes.

With the implementation of minimum and no tillage technologies on soil management groups, net income in the Basin changes as follows:

Scenario	Change in Basin Net Income (%)
Minimum Tillage on	
-Group 1 soils	+1.3
-Group 2 soils	+4.9
-Group 3 soils	-3.7
-Group 4 soils	-1.2
No Tillage on	
-Group 1 soils	+2.2
-Group 2 soils	+5.9

The economic impacts of reduced tillage systems on soil management groups 1, 2, 3, and 4 are relatively minor. In the case of soils in management groups 1 and 2, net income actually improves with the adoption of minimum and no tillage. With soils in management groups 3 and 4, net income declines when minimum tillage is implemented.

To project the impact of adopting reduced tillage systems on all four soil management groups, the following formula would be used:

$$\text{Percent Change in Basin Net Income} = \sum_{i=1}^{4} p_i a_i + \sum_{j=1}^{2} q_j b_j$$

where p_i = the percent of soils in management group i using minimum tillage, a_i = the percent change in Basin net income by using minimum tillage on soils in management group i, q_j = the percent of soils in management group j using no tillage, and b_j = the percent change in Basin net income by using no tillage on soils in management group j.

Thus, if minimum tillage would be adopted on 100 percent of the soils in the four management groups, the Basin net income would change by 1.3 percent (1.3 + 4.9 - 3.7 - 1.2).

If minimum tillage would be adopted on 50 percent of management groups 1 and 2 soils, no tillage adopted on the other 50 percent of management groups 1 and 2 soils, and minimum tillage adopted on 100 percent of management group 3 and 4 soils, the net income change sould be 2.3 percent [(.5) (1.3) + (.5) (4.9) - 3.7 - 1.2 + (.5) (2.2) + (.5) (5.9)].

While Basin net income actually improves with reduced tillage, the distribution of the income change is crucial. First, the adoption of minimum tillage or no tillage on management group 1 soils is beneficial throughout the Basin. Adoption of minimum tillage on group 2 soils does have adverse impacts on eastern counties. Similarly, adoption of no tillage on group 2 soils has adverse impacts on eastern counties. Even though the Basin's net income is improved dramatically with adoption of reduced tillage technologies on group 2 soils, some counties incomes are lowered. Most counties would experience income loss when minimum tillage is used on group 3 soils. Finally, using minimum tillage on group 4 soils would affect counties in the western part of the Basin. Eastern counties would be relatively unaffected due to the absence of group 4 soils.

CONCLUSIONS

The Lake Erie Wastewater Management Study earlier concluded that control of agricultural diffuse source pollution is necessary for the restoration of Lake Erie. An approximate 42 percent reduction in diffuse sources of phosphorus is necessary to restore Lake Erie. The bulk of the phosphorus from these diffuse sources reaches Lake Erie in association with suspended sediment transported during storm events. This suspended sediment emanates from soil loss throughout the Basin. Thus, there is strong indication that reducing gross erosion will reduce phosphorus loads in Lake Erie.

Employing reduced tillage practices on row crop acreage appears to be a logical method of reducing gross erosion in the Lake Erie Basin. It is estimated that erosion in the Basin could be nearly cut in half without a significant loss in net farm income through the adoption of reduced tillage practices on selected soils. Reduced tillage practices refer to a group of practices such as chisel plowing, field cultivating, discing, and no till planting which permit land used in row crops to have partial cover duing much of the year. Many soil series allow some or all of these reduced tillage practices to be adopted with a slight improvement in net farm income. However, there could be severe economic losses if reduced tillage technologies are adopted on other soils such as heavy clay or organic soils.

FOOTNOTES

[1]This study was mandated by Congress in PL 92-500. The Corps of Engineers was made responsible for conducting the study. Support for this research was provided by the Corps.

[2]Conventional tillage is moldboard plowing in the fall, winter, or spring followed by a disc, harrow, or field cultivator. Minimum tillage replaces the moldboard plowing with chisel plowing, discing, or field cultivating. With no tillage, weed control is accomplished with chemicals and the soil is not tilled. Reduced tillage refers to either minimum tillage or no tillage.

[3]County soil maps used to estimate yields were Wood, Henry, Putnam, Allen, Van Wert, Paulding, Erie, Huron, Richland, Summit, and Ashtabula in Ohio; Monroe county, Michigan; and Erie county Pennsylvania.

[4]Values for cation exchange capacity phosphorus test, and potassium test for soils in Indiana counties were assumed to be equal to those on soils in adjacent Ohio counties.

REFERENCES

Bone, S. W., D. M. Van Doren, Jr., and G. B. Triplett, "Tillage Research in Ohio," Bulletin 620, Cooperative Extension Service, The Ohio State University.

Davidson, C. E. and M. H. Erickson, "Alternative Economic Settlings for Agriculture: 1977-78," Agricultural-Food Policy Review, ERS AFPR-1, U.S. Department of Agriculture, 1977.

Department of Agronomy, 1978-79 Agronomy Guide, Bulletin 472, Cooperative Extension Service, The Ohio State University.

Follett, R. H. and J. F. Trierweiler, "Ohio Soil Test Summary 1971-72," Bulletin 561, Cooperative Extension Service, The Ohio State University.

Forster, D. L. and G. S. Becker, "Cost and Income Effects of Alternative Erosion Control Strategies: The Honey Creek Watershed," North Central Journal of Agricultural Economics, January, 1979.

Knoblauch, W. A., et al., "An Economic Analysis of New York Dairy Farm Enterprises," A.E.R.S. 78-1, Department of Agricultural Economics, Cornell University, January, 1978.

Lines, A., et al., "Ohio Crop Enterprise Budgets, 1978," MM-337, Cooperative Extension Service, The Ohio State University.

Mokma, D. L., et al., "Soil Management Units and Land Use Planning," Research Report 254, Agricultural Experiment Station, Michigan State University, 1974.

Mokma, D. L. and L. S. Robertson, "Soil Management Groups - A Tool for Communicating Soils Information," Journal of Agronomic Education, November, 1976.

Nott, W., et al., Enterprise Budgets, Michigan," Report 314, Department of Agricultural Economics, Michigan State University, June, 1977.

Rask, N. and D. L. Forster, "Corn Tillage Systems-Will Energy Costs Determine the Choice?" in Agriculture and Energy, Academic Press, Inc., 1977.

Reid, Shaw, Associate Professor of Soil Science, Cornell University, personal communication.

Robertson, L. S., "No-Till Corn: 3," Extension Bulletin E-906, Michigan State University, January, 1976.

Robertson, L. S., D. L. Mokma, and D. D. Warnke, "Test Levels in Soil Profiles of Michigan Corn Fields," Research Report 281, Agricultural Experiment Station, Michigan State University, July, 1975.

Taylor, C. R. and K. K. Frohberg, "The Welfare Effects of Erosion Control Banning Pesticides and Limiting Fertilizer Application in the Corn Belt," American Journal of Agricultural Economics, 59 (1977) 13-24.

Triplett, G. B., D. M. Van Doren, Jr., and Samuel W. Bone, "An Evaluation of Ohio Soils in Relation to No-Tillage Corn Production," Research Bulletin 1068, Ohio Agricultural Research and Development Center.

Urban, Don. Soil Scientist, Soil Conservation Service, personal communication.

Warnke, D. D., et al., Fertilizer Recommendations for Vegetable and Field Crops, Bulletin E-550, Cooperative Extension Service, Michigan State University, June, 1976.

PROJECTED ECONOMIC IMPACTS OF A DURABLE WHOLESALE TRADE FIRM ON LICKING COUNTY, OHIO*

How much could Licking County afford to invest in industrial site improvements to attract a durable wholesale trade firm? Would the area benefit or lose if a tax abatement is given to the firm? The attached results show the impacts on Lima Township, Licking County, and the Southwest Licking Local School District of a typical wholesale firm for durable goods.

It is estimated that 12 persons would be employed. Most of the community data came from reports issued by the state auditor and has not been verified with local officials. Data on the firm are derived from various reports issued by the U. S. Department of Commerce and the Ohio Bureau of Employment.

Based upon results of previous research, it was assumed that 40 percent of the new plant employees would be residents of Lima Township, 30 percent would commute from the rest of Licking County, 10 percent would move into the county, and 20 percent would commute from outside the county.

Changes in Local Incomes

Employees in Lima Township are estimated to earn $34,339 more than they would otherwise in the first year if the firm is established. Employees in the rest of Licking County should earn $23,915 more in the first year. Depending on where they live, these employees are estimated to spend from 10 to 50 percent of their new income in Lima Township. The incomes of other area merchants and their employees would increase by $5,415 in the first year.

Public Finance Impacts of New Jobs

The tax base in the county would expand enough to provide the township, the county, and the school district with greater increases in revenues than in expenditures. However, these net gains were quite small for all three units. In the first year the net gains were $114, $405, and $606 for the township, county, and school district.

For the township and county the net gains increase over the ten year period due to projected increases in the real wages at this firm. The school district impacts have an uneven pattern as a result of the Ohio education finance system which combines an equal yield formula for state aid, a guarantee of no reduction in state aid from one year to the next, and property values which change only once every three years.

Local Investments in Site Improvements

The bottom two lines of Table 1 show the breakeven investment for attracting this firm. It's labeled "Present Value Over 10 Years at 5.0" and it shows the value today of these surpluses over the entire period. If the firm operates in the location for ten years with 12 employees, the township could invest up to $1,509. That is, the township could invest up to $1,509 without raising local tax rates. The county could invest another $4,429.

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*Prepared by George Morse, Resource Economist, and John David Gerard, Technical Assistant, Economic Research, Department of Agricultural Economics and Rural Sociology, Ohio Agricultural Research and Development Center and the Ohio State University, December 1979, ESO 651.

The county and township could divide these investments based on their expected net benefits or approximately a 75 to 25 percent division.

The results for the school demonstrate an important consideration: the stability of the firm must be considered. Dun and Bradstreet data show that a large percentage of firms fail each year. If this firm successfully operates here for 10 years, the present value of the net gains to the school district is $5,443. If it fails during this period, the results are reversed, with a net loss of $29,328. This negative result assumes that expenditure declines do not result immediately after a plant fails and that they only decline by 75 percent of the original increase. While all local units of government are affected by this, schools are affected more severely because of the larger amounts of funds involved.

Tax Abatement

If a fifteen-year tax abatement is given to this firm, using the Community Reinvestment Program, the net gains to the township in year 1 would be 28 percent less than without the abatement. In this program the abatement applies only to taxes on improvements to real property and not to tangible personal property taxes, income taxes, or sales taxes.

The net gains to the county would drop by only 6 percent. This is because the township's additional local revenue comes entirely from property taxes. However, over half of Licking County's additional revenues would come from the one-half percent permissive sales tax.

Use Alternative Estimates and Check the Data

These estimates are derived from the Ohio Economic Growth Impact Model. The data used in this analysis are attached. Because the model has been computerized, different situations can be easily examined.

These results represent the first of a three-phase program. If local decisions are being made about the level of public investment for a firm, specific data on that firm must be studied.

A careful review of the other data used in the analysis is also desirable. For example, users frequently are uncertain about where new employees will live. How many already live in the township, county, and school district? How many will commute in from other areas? How many will move in? The base analysis shown here assumes 40 percent already lived in the township with 30 percent coming from the rest of the county. As Table 3 shows, the net gain in year one to the township ranges from $93 to $135 if the percentage in the township is 20 and 60 percent, respectively. This type of analysis cannot remove all the uncertainty and risk involved. It can help to focus attention on the key local issues in local growth policies.

For more information on this service, contact George Morse, Resource Economist, GROW Community Development Project, P. O. Box 32, Jackson, Ohio 45640 (614/286-2177).

Table 1

PUBLIC FINANCE IMPACTS OF NEW JOBS

FIRM CODE: 5000
COMMUNITY: LIMA TWP

INDUSTRY CODE: DUR WHLS TRD   DATA CODE: 000301
SCHOOL DISTRICT: SW LICKING LOCAL   COUNTY: LICKING

ANNUAL NET BENEFITS TO:

	CITY	COUNTY	SCHOOL DISTRICT
YEAR 1	114.	405.	506.
YEAR 2	154.	482.	539.
YEAR 3	230.	602.	1185.
YEAR 4	216.	599.	1057.
YEAR 5	202.	593.	417.
YEAR 6	226.	631.	721.
YEAR 7	212.	619.	585.
YEAR 8	199.	609.	459.
YEAR 9	223.	646.	773.
YEAR 10	209.	635.	636.
PRESENT VALUE OVER 10 YEARS AT 5.0% INTEREST	1509.	4429.	5443.
PRESENT VALUE ADJUSTED FOR PLANT FAILURE	726.	2465.	-29328.

Table 2

Detailed Estimates for Year 1

BENEFITS, COSTS AND NET GAINS FROM NEW JOBS

IN COMMUNITY OF LIMA TWP
IN A DUR WHLS TRD FIRM
EMPLOYING 12 ADDITIONAL WORKERS

PRIVATE SECTOR BENEFITS	YEAR 1
NEW INCOME, EMPLOYEES IN CITY	34339.
NEW INCOME, EMPLOYEES IN COUNTY	23915.
NEW INCOME, SERVICE SECTOR	5415.
CITY GOVERNMENT	
ADDITIONAL REVENUES	
PROPERTY TAXES, NEW PLANT	38.
PROPERTY TAXES, NEW HOMES	56.
PROPERTY TAXES, ADDITIONAL TANGIBLE	109.
INCOME TAX	0.
STATE AID	8.
MISC TAXES, NEW RESIDENTS	0.
TOTAL	210.
ADDITIONAL EXPENDITURES	
POLICE	0.
FIRE	11.
WATER	0.
SEWER	0.
STREETS	85.
OTHER	0.
CAPITAL EXPENSES	0.
TOTAL	96.
NET REVENUES	114.
COUNTY GOVERNMENT	
ADDITIONAL REVENUES	
PROPERTY TAXES, NEW PLANT	30.
PROPERTY TAXES, NEW HOMES	73.
PROPERTY TAXES, ADDITIONAL TANGIBLE	85.
SALES TAX	226.
STATE AID	1.
MISC TAXES, NEW RESIDENTS	15.
TOTAL	430.
ADDITIONAL EXPENDITURES	
CAPITAL EXPENSES	0.
SERVICES, NEW RESIDENTS	25.
TOTAL	25.
NET REVENUES	405.
SCHOOL DISTRICT	
ADDITIONAL REVENUES	
PROPERTY TAXES, NEW PLANT	166.
PROPERTY TAXES, NEW HOMES	408.
PROPERTY TAXES, ADDITIONAL TANGIBLE	526.
STATE AID	1435.
MISC REVENUES	252.
TOTAL	2788.
ADDITIONAL EXPENDITURES	
OPERATING EXPENSES, NEW STUDENTS	2182.
CAPITAL EXPENSES	0.
TOTAL	2182.
NET REVENUES	606.

Table 3

Alternative Estimates of the Public
Finance Impacts of the Durable
Wholesale Trade Firm on Licking County, Ohio

Alternative Assumptions	Lima Township	Licking County	Southwest Licking School District
1. Base Analysis[a]			
Year 1 impacts	$ 114	$ 405	$ 606
Present value over 10 years at 5%	$1,509	$4,429	$5,443
2. Fewer Township Workers[b]			
Year 1 impacts	$ 93	$ 390	$ 606
Present value over 10 years at 5%	$1,075	$4,264	$5,415
3. More Township Workers[c]			
Year 1 impacts	$ 135	$ 420	$ 605
Present Value over 10 years at 5%	$1,943	$4,595	$5,471

(a) Workers from Township = 40%, 30% from rest of county
(b) Workers from Township = 20%, 50% from rest of county
(c) Workers from Township = 60%, 10% from rest of county

Table 4

DATA USED IN ANALYSIS	000301
SECTION ONE: FIRM AND EMPLOYMENT DATA	
1 INDUSTRIAL CLASSIFICATION	
A. TYPE OF BUSINESS	DUR WHLS TRD
B. SIC CODE	5000
2 LOCATION OF NEW FIRM	
A. VILLAGE OR CITY	LIMA TWP
B. SCHOOL DISTRICT	SW LICKING LOC/
C. COUNTY	LICKING
3 NEW JOBS CREATED	12
4 RESIDENTIAL LOCATION OF WORKERS (PERCENT OF TOTAL)	
A. MUNICIPAL RESIDENTS	0.40
B. REST OF COUNTY RESIDENTS	0.30
C. IN-MIGRANTS TO THE CITY	0.05
D. IN-MIGRANTS TO THE COUNTY	0.05
E. COMMUTERS FROM OUTSIDE COUNTY	0.20
5 AVERAGE ANNUAL WAGES	
A. FOR LOCAL EMPLOYEES	12775.
B. FOR IN-MIGRANTS	14691.
C. ANNUAL RATE OF CHANGE	0.090
6 NEW PLANT'S MARKET VALUE	
A. BUILDINGS AND OTHER REAL PROPERTY	23721.
B. TANGIBLE PERSONAL PROPERTY	34552.
7 PERCENTAGE OF WORKERS' INCOMES SPENT IN THE MUNICIPALITY AND COUNTY	
A. BY MUNICIPAL RESIDENTS IN CITY	0.400
B. BY MUNICIPAL RESIDENTS IN COUNTY	0.500
C. BY REST OF COUNTY RESIDENTS IN CITY	0.300
D. BY REST OF COUNTY RESIDENTS IN COUNTY	0.400
E. BY COMMUTERS IN CITY	0.100
F. BY COMMUTERS IN COUNTY	0.250
8 FAMILY SIZE PER EMPLOYEE	3.500
9 INCOME MULTIPLIER	1.200
10 RATIO OF HOME VALUES TO INCOME	2.000

SECTION TWO: TAX DATA

1	PROPERTY TAX RATES AND REDUCTION FACTORS	
A.	COUNTY INSIDE MILLAGE	2.200
B.	COUNTY OUTSIDE MILLAGE	1.800
C.	COUNTY TAX REDUCTION FACTOR	0.238246
D.	SCHOOL INSIDE MILLAGE	4.900
E.	SCHOOL OUTSIDE MILLAGE	19.800
F.	SCHOOL TAX REDUCTION FACTOR	0.252354
G.	CITY INSIDE MILLAGE	2.700
H.	CITY OUTSIDE MILLAGE	2.400
I.	CITY TAX REDUCTION FACTOR	0.234033
2	YEAR OF LAST APPRAISAL OR UPDATE	1978
3	EXPECTED ANNUAL RATE OF CHANGE IN PROPERTY VALUES	0.080
4	SCHOOL DISTRICT TAX BASE - TAXABLE VALUES	
A.	REAL PROPERTY	57258110.
B.	TANGIBLE PERSONAL PROPERTY	3619250.
C.	TANGIBLE PERSONAL PUBLIC UTILITY PROPERTY	9589827.
D.	YEAR TO WHICH VALUATIONS APPLY	1980

SECTION THREE: COUNTY DATA

1	COUNTY PERMISSIVE SALES TAX RATE	0.005
2	CHANGES IN STATE AND FEDERAL AID	1.00
3	MISCELLANEOUS COUNTY REVENUE PER CAPITA	7.05
4	COUNTY OPERATING EXPENSES PER CAPITA	
A.	CURRENT OPERATING EXPENSES	11.71
B.	EXPECTED RATE OF CHANGE	0.070
5	TOTAL ANNUAL CAPITAL COSTS	
	YEAR 1	0.0
	YEAR 2	0.0
	YEAR 3	0.0
	YEAR 4	0.0
	YEAR 5	0.0
	YEAR 6	0.0
	YEAR 7	0.0
	YEAR 8	0.0
	YEAR 9	0.0
	YEAR10	0.0
	YEAR11	0.0
	YEAR12	0.0
	YEAR13	0.0
	YEAR14	0.0
	YEAR15	0.0
	YEAR16	0.0
	YEAR17	0.0
	YEAR18	0.0
	YEAR19	0.0
	YEAR20	0.0

SECTION FOUR: SCHOOL DISTRICT DATA

1	ENROLLMENT	
A.	CURRENT AVERAGE DAILY ENROLLMENT	3098
B.	ANNUAL RATE OF CHANGE IN ENROLLMENT	0.0
C.	INCREASE IN ENROLLMENT DUE TO NEW PLANT	2
2	TOTAL STATE BASIC AID IN YEAR BEFORE STUDY	1841475.
3	ANNUAL RATE OF CHANGE IN STATE SUPPORT	0.070
4	TOTAL CURRENT TRANSPORTATION AID	9968.
5	MISCELLANEOUS REVENUE PER PUPIL	126.00
6	SCHOOL OPERATING EXPENDITURES PER PUPIL	
A.	CURRENT	1091.00
B.	ANNUAL RATE OF CHANGE	0.080
7	ADDITIONAL CAPITAL COSTS	
	YEAR 1	0.0
	YEAR 2	0.0
	YEAR 3	0.0
	YEAR 4	0.0
	YEAR 5	0.0
	YEAR 6	0.0
	YEAR 7	0.0
	YEAR 8	0.0
	YEAR 9	0.0
	YEAR10	0.0
	YEAR11	0.0
	YEAR12	0.0
	YEAR13	0.0
	YEAR14	0.0
	YEAR15	0.0
	YEAR16	0.0
	YEAR17	0.0
	YEAR18	0.0
	YEAR19	0.0
	YEAR20	0.0

SECTION FIVE: MUNICIPAL DATA

1	MUNICIPAL POPULATION	
A.	CURRENT	4199
B.	ANNUAL RATE OF GROWTH	0.0
2	MUNICIPAL INCOME TAX RATE	0.0
3	YEARS OF TAX ABATEMENT	0
4	CHANGES IN STATE AND FEDERAL AID	8.00
5	MISCELLANEOUS REVENUE PER CAPITA	0.0
6	CURRENT ANNUAL OPERATION COST PER PERSON OF MUNICIPAL SERVICES	
A.	POLICE	0.0
B.	FIRE	2.72
C.	WATER	0.0
D.	SEWER	0.0
E.	STREETS	21.35
F.	OTHER	0.0
7	ADDITIONAL ANNUAL OPERATIONAL COSTS FOR MUNICIPAL SERVICES	
A.	POLICE	0.0
B.	FIRE	11.00
C.	WATER	0.0
D.	SEWER	0.0
E.	STREETS	85.00
F.	OTHER	0.0
8	CAPITAL INVESTMENTS BY MUNICIPALITY	
	YEAR 1	0.0
	YEAR 2	0.0
	YEAR 3	0.0
	YEAR 4	0.0
	YEAR 5	0.0
	YEAR 6	0.0
	YEAR 7	0.0
	YEAR 8	0.0
	YEAR 9	0.0
	YEAR10	0.0
	YEAR11	0.0
	YEAR12	0.0
	YEAR13	0.0
	YEAR14	0.0
	YEAR15	0.0
	YEAR16	0.0
	YEAR17	0.0
	YEAR18	0.0
	YEAR19	0.0
	YEAR20	0.0

SECTION SIX: OTHER DATA

1	LENGTH OF ANALYSIS	10
2	DISCOUNT RATE	0.050
3	RATE OF INFLATION	0.070
4	RATIO OF VALUE ADDED TO SALES SERVICE SECTOR	0.200
5	PROPORTION OF NEW HOUSING OUTSIDE COMMUNITY REINVESTMENT AREA	
A.	IN THE CITY	0.900
B.	IN THE COUNTY	0.950
6	INCOME LEAKAGE FACTOR	
A.	IN THE CITY	0.30
B.	IN THE COUNTY	0.35
7	RATE OF DEPRECIATION	0.04
8	CUMULATIVE PROBABILITY OF PLANT FAILURE	
	YEAR 1	0.014
	YEAR 2	0.097
	YEAR 3	0.225
	YEAR 4	0.353
	YEAR 5	0.481
	YEAR 6	0.543
	YEAR 7	0.605
	YEAR 8	0.667
	YEAR 9	0.699
	YEAR10	0.731